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Steel Extension Bracket for Wall Insulation Retrofits

Research Report

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Canada

Canada Mortgage and Housing Corporation, the Federal Government's housing agency, is responsible for administering the National Housing Act.

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Under Part V of this Act, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research. CMHC therefore has a statutory responsibility to make widely available, information which may be useful in the improvement of housing and living conditions.

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STEEL EXTENSION BRACKET

FOR

WALL INSULATION RETROFITS

Prepared for

the Research and Project Implementation Divisions

Policy Development and Research Sector

Canada Mortgage and Housing Corporation

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Development of original concept	Ecodomus Ltd., Ottawa
Development of bracket and mechanical testing	Dofasco Ltd., Hamilton
Thermal performance testing	Division of Building Research National Research Council Ottawa
Demonstration project	Gil Bern Charles (Corp) Ltd Ottawa

This summary report was prepared by Kathy Greiner

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INTRODUCTION

Canada Mortgage and Housing Corporation, in cooperation with Dofasco, Inc. has developed steel extension brackets for use in the exterior retrofit of walls; the brackets are fastened to wood members which together form spacer assemblies. The original concept was developed by Ecodomus Developments Ltd. and, after refinements were made to this first prototype, Dofasco was retained to further develop and test the spacer. In 1982 Canada Mortgage and Housing Corporation undertook a demonstration of the steel spacer system on a publicly owned residence to determine its suitability for use in retrofitting. This report summarizes the work undertaken by Dofasco in developing the steel bracket and the demonstration project undertaken by Canada Mortgage and Housing Corporation.

I DEVELOPMENT OF THE STEEL BRACKET

Using the original concept developed by Ecodomus Developments Ltd., a 2.44 m x 2.44 m wall was constructed and tested for thermal properties in the Environmental Test Facility, Division of Building Research, National Research Centre, Ottawa. At this point it was concluded that the concept had sufficient merit for continued development and refinements were made to the prototype to reduce mechanical "overdesign", thermal bridging, and the occurrence of cavities within the structure which could not be easily filled with batt insulation.

Subsequently, Dofasco was asked to undertake the further development of the steel bracket.

A. Scope of Work of Dofasco, Inc.

Using the prototype provided by CMHC, Dofasco was contracted to undertake a two-phase project. Under Phase I Dofasco was asked to:

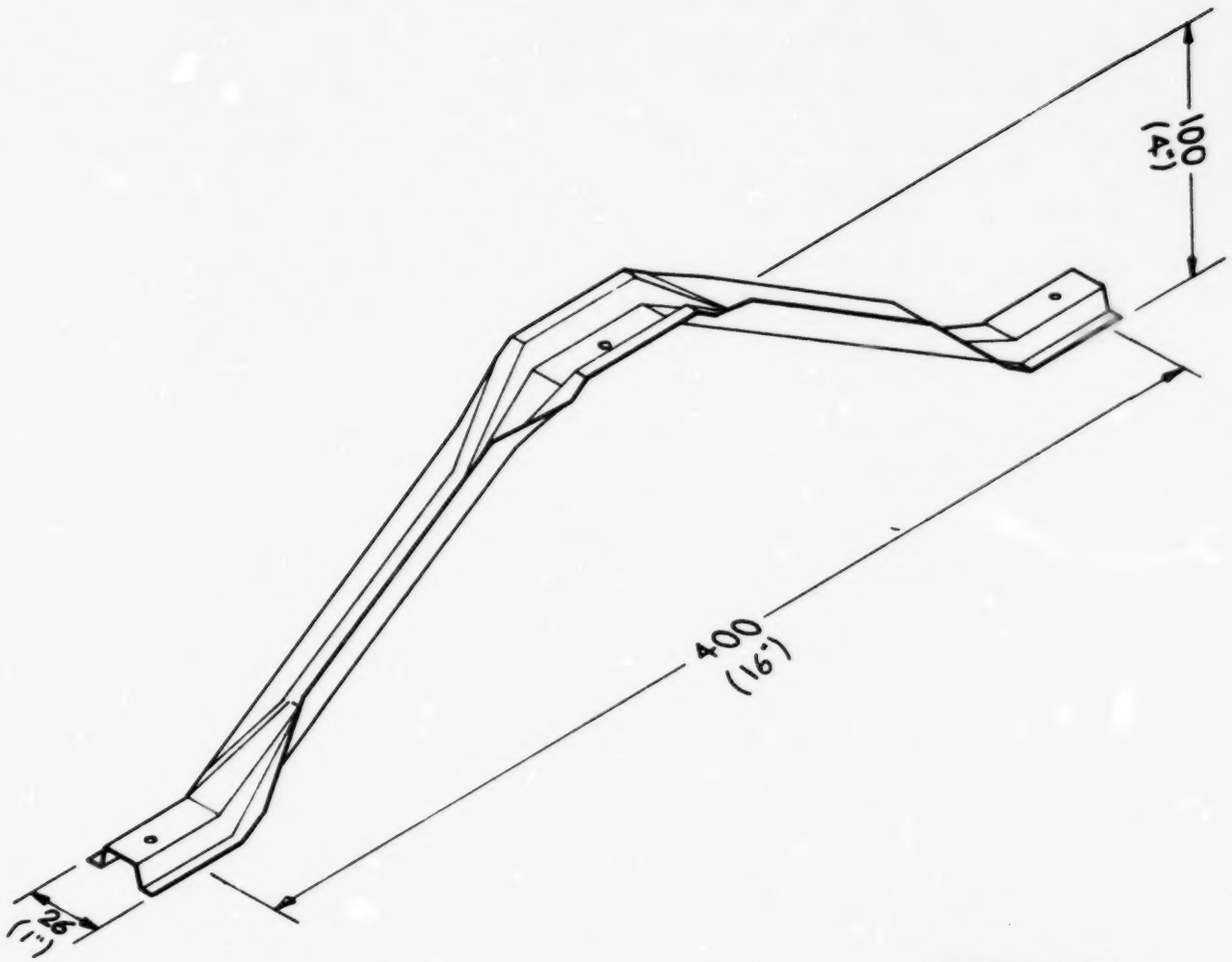
1. Revise the component design to optimize strength, thermal resistance, and economic savings;

2. Produce the tooling required for a limited production run of such a system;

3. Erect a 2.44 m x 2.44 m prototype wall using the redesigned steel bracket. The bracket developed which met the objectives is shown in Figure 1.

In the second phase Dofasco was asked to:

1. Undertake testing on wind loads; the effectiveness of fasteners used; and thermal efficiency of the system.



DIMENSIONS ARE
IN MILLIMETRES
UNLESS NOTED.

FIG. 1

THE REDESIGNED BRACKET

2. Determine the projected costs of producing the steel bracket system.

3. Develop methods to close off the wall cavity at the top, bottom and at wall openings, when the steel bracket system is used for insulation.

4. Manufacture approximately 800 spacers to be used in a demonstration unit.

B. Findings

1. Bracket Resistance to Wind Pressure and to Wind Suction

Dofasco conducted tests on the spacer system under a design wind pressure of 1.20 kN/m^2 (160 kph wind including gusts); these tests determined that the system has more than adequate strength for resisting wind pressure.

Two suction tests, one using concrete blocks, and the second using hydraulic cylinders, were conducted to determine the system's resistance to wind suction. These tests concluded that it has more than adequate strength for resisting the load caused by wind suction. In fact, in some applications, every second bracket may be omitted from the spacer assembly. This would reduce the number of

screw connections to the existing wall by 50 per cent, resulting in a corresponding decrease in the assembly's resistance to wind suction. However, in most applications the pullout strength of the fasteners is adequate to resist typical wind loads.

2. Fastener Pullout

The brackets, which are typically nailed to the 38 mm x 38 mm wood furring which then attached to the wall, were subjected to pullout tests to determine the fastener's ability to withstand wind suction. These tests determined that a very large factor of safety can be achieved by fastening the brackets into the existing studs in the house. Consequently, when attaching the spacer assembly to the existing wall of a house during retrofitting, the strength of the existing exterior sheathing should be assessed. If its ability to withstand wind suction and pressure, or its capacity to hold screws, is uncertain, the spacer assembly should only be fastened to the existing wall studs.

3. Thermal Efficiency

The thermal resistance of the system was tested in the Environmental Test Facility, Division of Building Research, National Research Centre, Ottawa. The tests found that the thermal performance of the system was within 2 per cent of the calculated value of 3.23 m^2 K/W. With outside and inside air temperatures established at -35°C

and 21°C respectively, the thermal resistance added by the retrofit system was 3.17 m^2 K/W.

4. Bracket Costs

Dofasco estimated production costs, including direct labour, material, and tooling would be about 9 cents per bracket. Distribution costs would be extra.

5. Closure of Wall Cavities

For retrofit spacers at 406 mm centres, full width friction fit fibreglass batts intended for use with steel C-studs should be specified. This will minimize any air gap behind the bracket and thus maximize the thermal resistance of the wall.

II DEMONSTRATION PROJECT

A. Scope of Work

Canada Mortgage and Housing Corporation undertook the demonstration of this steel-bracket retrofit system on a wood-frame housing unit at 734 Carson Road in Ottawa which was made available through the cooperation of the City of Ottawa Non-Profit Housing Corporation. The Ottawa-based firm, Gil Bern Charles (Corp.) Ltd., was the contractor selected to undertake the retrofit.

In order to compare the practical use of spacer assemblies with an alternative method, the steel spacer system was used on the north and east walls and an all wood "eggcrate" system was used on the south and west walls of the house. This allowed a comparison to be made on the simplicity of application as well as on the approximate costs of the two systems.

The contract called for the removal of the existing horizontally applied wood siding and any building paper that might be located under it, and the installation of a 6 mil polyethylene sheet over the exterior walls to the level of the basement window sills. While extending the new wall to the level of the basement window sills was done primarily for aesthetic reasons, some insulation value was also provided to the basement walls.

The brackets were attached on site to spruce furring with #6, 25 mm long Robertson Socket Drive Pan Head Wood Screws, then fastened vertically to the walls at 406 mm centres with #6, 50 mm wood screws. The wall studs of the existing structure served as the fastening base, with RSI 3.5 (R20) fibreglass insulation batts used to fill the space between the brackets. Figures 2 and 3 show the demonstration house in the process of retrofitting.

FIG.2

FIG. 3

PHOTOGRAPHS OF DEMONSTRATION PROJECT

For the eggcrate system 38 mm x 76 mm wood members were horizontally fastened to the walls at 609 mm centres to accommodate RSI 2.1 (R12) fibreglass insulation batts. More 38 mm x 76 mm wood members were placed vertically on top of the strapping and additional RSI 2.1 (R12) fibreglass insulation batts were used to fill this space, for a total insulation value of RSI 4.2. Fastening was accomplished by toe-nailing with four 63 mm nails on each stud junction of the vertical members; two 82 mm nails were used at each crossover point with the horizontal members.

Subsequently, both systems and their insulation were covered with sheathing paper conforming to CAN 2-51-32 M77 "Sheathing Membrane, Breather Type" followed by 8 mm exterior grade plywood to provide support for the aluminum siding. In addition, on the eggcrate system, since the plywood sheets were supported at 609 mm centres, a horizontal cross member was installed between the vertical members where the plywood sheets were joined to forestall any bowing.

In both systems, the door and window openings were boxed with 25 mm solid pine and a sill slope of 8° was maintained for window and door sills. The doorsill extensions were covered with an aluminum sill extender. Finally, the exterior of the house was covered with white finished aluminum siding conforming to CGSB Standard 93-GP-2M 1978; new aluminum gutters and downspouts were also installed.

B. Problems Encountered and Changes Made to the Metal Bracket System During Installation

1. The recommended installation instructions called for the securing of a 38 mm x 38 mm wood ledger to the soffitt, with the outer face of the ledger to be located 92 mm from the outer face of the sheathing, and the top of the stud assembly fastened to the ledger. The contractor felt this would not offer a stable nailing base and a 38 mm x 139 mm plank was substituted. Had the 38 mm x 38 mm ledger been used, as proposed, it would have been necessary to brace in between each stud assembly.

2. The 38 mm x 140 mm x .91 mm galvanized steel angle recommended as the bottom enclosure of the wall assembly was not used since it was considered to be an "overdesign". It was replaced by a 38 mm x 139 mm wood plank. This turned out to be a wise decision since the basement walls were not straight, which would have made it difficult to affix the metal plate to the wall. The gaps between the concrete and wood plate were covered by infilling with smaller pieces of wood; such a step would have been difficult to do with the steel angle. The brackets, attached to the wall by a power tool, held the 38 mm x 139 mm wood plate in place until the spacers were attached to it.

3. Shimming was required on about 60 per cent of all the brackets since the walls were out of plumb by as much as 25 mm. The

brackets, with seven per assembly, required over 50 per cent more contact points with the building than did the eggcrate system. While shimming was also required for the eggcrate system, this was more easily achieved. The horizontal furring could be nailed directly to the wall; shimming was then done under the vertical members into the much larger and more visible nailing base.

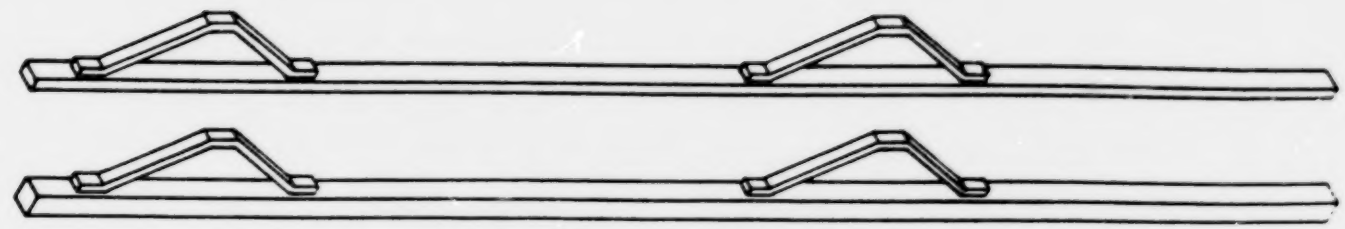
4. Where shims were not required for the spacer system, care had to be used in driving the mechanical fasteners to the wall. If too much pressure was applied to the electric drill or by a hammer blow to the wall, the face of the metal plate tended to damage the vapour barrier. Another difficulty experienced in fastening the brackets to the wall was that they had to be driven or screwed at an angle since there was insufficient space between the studs and the wall to allow the electric drill to face it squarely. The same problem also arose with the brackets that were nailed on when a good base for the screw could not be located.

5. Fitting insulation with the spacer assemblies presented initial difficulties but were soon resolved. The recommended 152 mm thick fibreglass insulation batts were too rigid to nest closely into the brackets and around the wood studs. Large voids were observed, possibly due to the binder used in the insulation

manufacture which created a relatively rigid product. The contractor subsequently replaced the 152 mm batts with the much more flexible 89 mm batts. The first layer was hand fitted around the brackets. The second layer of 89 mm batts was split along its length to allow the back half of the batt to be fitted around the steel brackets, while the outer half was compressed and fitted between the wood members. Such an application proved to be a satisfactory, although slower, installation procedure. The installation of the insulation was much faster on the eggcrate system since the batts could be friction fitted between the studs and required very little cutting and fitting.

III COMMENTARY ON THE DEMONSTRATION PROJECT

Based on the experience gained from the demonstration project, a simpler, and probably less costly installation method could be used with the steel brackets. This revised method involves attaching a 19 mm x 38 mm inner-side furring strip to the brackets, as illustrated in Figure 4, before nailing the assembly to the wall. A prototype, using this method, has been built but not yet tried on site. While the cost of the furring strip and the slightly longer preassembly time must be considered, this revised assembly procedure could provide several advantages over the method used in the demonstration project. These advantages are as follows:



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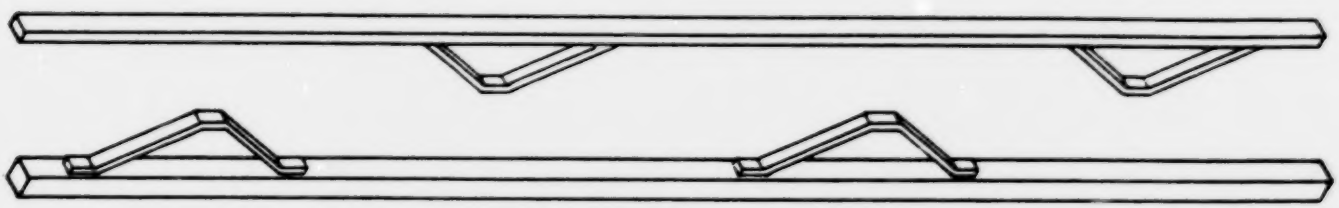

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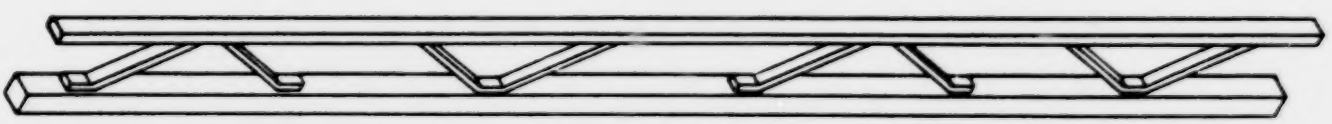

(iii)

FIG. 4

SPACER ASSEMBLY

1. The spacer assembly could be attached to the wall by nails instead of screws; the use of nails could be expected to result in faster attachment to the wall.

2. The furring would provide a more suitable arrangement for installing shims, if shimming is required.

3. The furring would be less likely to damage the vapour barrier.

4. Installing fasteners on an angle would be reduced if the sequence of assembly shown in Figure 4 is adopted.

5. The furring would make it practical to decrease the number of steel brackets, reducing both the total cost for brackets and the amount of thermal bridging by one-third. For example, a 2.4 m length of "extended stud" would require only 4 brackets instead of 6. The number of fasteners would remain the same so that fastener holding power, which is the limiting factor in the strength of the assembly, should remain constant. It can be predicted that the testing of the revised assembly would lead to results similar to those obtained on the Dofasco prototype.

Consideration should be given to further test this proposed system by having a contractor use the revised installation technique proposed above.

Subsequently, an assessment of this method in comparison with the eggcrate and other similar techniques, including rigid insulation, should be done to identify the potential for the commercial application of the steel extension bracket in upgrading the insulation and airtightness of buildings.

IV OTHER APPLICATIONS

In addition to the product's usefulness in exterior retrofits, a number of other applications are possible and could apply to new construction as well.

The spacer assembly could be used in the construction of service walls, false floors, and dropped ceilings; and on the underside of cantilevered floors.

Although the initial test focused on retrofitting, further testing may demonstrate a number of new uses for the system which could be applied in both old and new construction.

More detailed descriptions of the product and results of tests carried out are available from the Canadian Housing Information Centre, Canada Mortgage and Housing Corporation.